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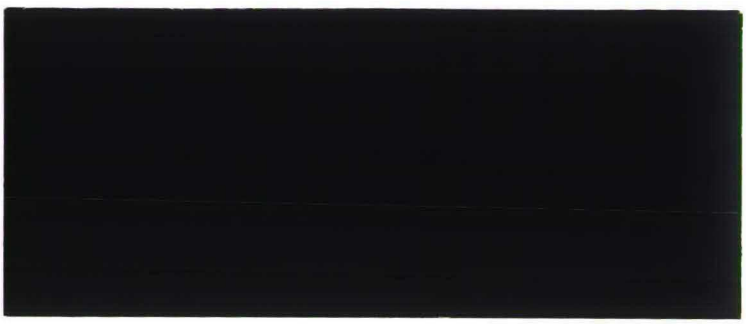

DEPARTMENT OF ECONOMICS

RESEARCH MEMORANDUM

THE NEW COCOA-AGREEMENT ANALYSED

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THE NEW COCOA-AGREEMENT ANALYSED

by

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ABSTRACT

Commodity agreements have been functioning for many years. However, it is only recently that two agreements have been concluded which do not rule out success in advance. One of these agreements is the 1986 cocoa agreement. Using an annual model of the cocoa market this article analyses the viability of the instruments agreed upon and explores ways and means to improve the functioning of the agreement.

Keywords: Commodity agreement, price stabilization, buffer stock policy, withholding.

1 INTRODUCTION

On the occasion of its adoption in July 1986 the new International Cocoa Agreement was described by Kenneth Dadzie, Secretary-General of UNCTAD, as 'the first of a new generation of International Commodity Agreements' (ICA) (UNCTAD 1986a). The justification for such a bold statement is that, for the first time in history, the objective of an ICA is exclusively geared towards the reduction of price fluctuations around the long term market-determined trend. Stabilization of prices (and as a consequence income) is the sole objective of the agreement (see article one of the 1986 cocoa agreement).

From a theoretical point of view there are some objections against the use of the price trend as guideline for price stabilization, if the market cannot be described by a linear model. From the work of Turnovsky (1976, 1978) and Nguyen (1979, 1980) we know that this is only warranted in case the Waugh-Oi-Massell model is valid. In a general non-linear model with multiplicative disturbances the arithmetic price trend will not lead to a realistic buffer stock policy. Realistic in the sense that it fulfills the requirements of (i) earnings stabilization and (ii) self-liquidation. However, it can be shown that in case of a log-linear model the geometric price trend is appropriate.

The tin-disaster and other interventions, such as the Common Agricultural Policy (CAP) of the European Commission, confirm the theory. The main lesson is that buffer stock intervention should not go against the general tendency of the market (or more precise: market prices). Incorporating this lesson in a model of a commodity market means that the decision rule for selling or buying by the buffer stock manager (i) should not alter the market price trend determined by supply and demand and (ii) should not ignore changes in prices induced by factors from outside the market. The objective of this article is to see whether a decision rule can be formulated for the buffer stock manager on how to act in order not to violate these two principles and to analyse the viability of the 1986 cocoa agreement with respect to these principles for a stabilization policy.

In section 2 we will briefly discuss the new cocoa agreement. In section 3 an annual model of the cocoa market and its main features are presented. In section 4 the model will be used to formulate some heuristic rules for market intervention. Section 5 contains the simulation results and a comparison of the effects of the agreement with the heuristic rule of section 4. The final section contains conclusions.

2 THE 1986 COCOA AGREEMENT

The cocoa agreements of 1972 and 1975 were not effective at all because the cocoa price never was within the agreed price range. The agreement of 1980 only had a minor impact, although the buffer stock manager bought 100,000 mt in the 1981/82 season. The main reason for the ineffectiveness of the agreements was that they did not contain provisions for (semi-)automatic revisions of the price range whenever necessary. The rubber agreement of 1979 was the first commodity agreement with a semi-automatic adjustment of the range, partly related to changes in the size of the buffer stock. In the 1987 Rubber Agreement the mechanism of semi-automatic adjustment of the price range was strengthened considerably.

However, the decisive factor in shaping the character of the recent cocoa agreement was the collapse of the tin agreement in 1985, basically due to

prolonged attempts to maintain the tin prices at an artificially high level. As a direct consequence of this failure, the UNCTAD Committee on Commodities decided on new guidelines for commodity agreements. The major point of these guidelines was that future agreements should be designed in such a way that they take into account developments in market prices to a larger degree (UNCTAD 1987).

The 1986 cocoa agreement is characterized by a relatively wide price range, two stabilization instruments and a high degree of price flexibility (UNCTAD 1986b). In the agreement the upper and lower intervention prices ('must sell' and 'must buy' prices) have been set at 267 US-dollar cents and 187 US dollar cents per kilo respectively, or at a distance of 40 US-dollar cents from the reference price of 227 US-dollar cents per kilo (SDR 1.935 at the time of adoption of the agreement; UNCTAD 1986a). This means a range of $\pm$ 17.6% from the reference price, which is smaller than the range in the 1979 rubber agreement ($\pm$ 20%) (UNCTAD 1980), but wider than the range of the 1980 cocoa agreement ($\pm$ 15.4%) (UNCTAD 1982). The principal instrument in the new agreement is a *buffer stock* of 250,000 mt (as in the agreement of 1980) with the possibility of an additional 100,000 mt should the agreement (after three years) be extended for a period of more than one year. The stock resulting from the old agreement (100,000 mt) and a capital of 250 million US-dollar have been transferred to the new agreement. Additional funds for buffer stock operations will continue to come from a levy of 2 US-dollar cents per lb.

An interesting new feature of the 1986 agreement is a *withholding* scheme. This is essentially a system of national stocks (kept in store by the buffer stock manager) up to a maximum of 120,000 mt. The scheme becomes operative (in tranches of 30,000 mt) once the buffer has reached 200,000 mt or the manager runs out of funds. The impact of withholding is the same as buying by the buffer stock manager. However, there is a significant difference in the unloading of these two types of stocks. Stocks from the buffer are sold whenever the price reaches the upper intervention level. Withholdings are already released at the reference price; so, only the lower half of the price range is relevant for this instrument.

The most important new feature of the 1986 cocoa agreement is the flexibility of the price range due to two types of semi-automatic adjustment of the intervention prices. The first type relates to the *annual price review*. In case the average indicator price over the preceding year has been outside the range, the intervention prices will be increased (decreased) to such an extent that the indicator price comes at a distance of 6 US-dollar cents from the intervention price within the range, with a maximum adjustment of 13 US-dollar cents per kilo, unless the Cocoa Council decides otherwise by special vote.

The second type of semi-automatic adjustment is triggered by a *change in the size of the actually held buffer stock* of 75,000 mt within a six month period. In that case the adjustment of the intervention prices is 13 US-dollar cents per kilo. In the earlier cocoa agreement the comparable adjustment mechanism was almost 9 US-dollar cents per kilo. Taking both semi-automatic adjustments into account it turns out that the 1986 cocoa agreement contains the most flexible adjustment of the price range that has ever been incorporated in a commodity agreement.

A not unimportant novelty of the 1986 agreement is that all prices are expressed in SDR's. Using the SDR as a denominator instead of the US dollar has the advantage that the prices of the agreement are less distorted by all changes of the dollar vis a vis the major other currencies in the world. A substantial appreciation or depreciation of the dollar will influence the nominal cocoa prices expressed in dollars. By using the SDR as a denominator, these price changes will be mitigated. Theoretically one should use a basket of the currencies of all major consumer countries, with a weighting of the currencies according to their shares in cocoa consumption. However, the SDR is an acceptable substitute as unit of account.

3 A SIMPLE MODEL OF THE COCOA MARKET

Cocoabeans are produced in developing countries and cocoa products are mainly consumed in developed countries. This dichotomy was used in formulating a model of the world cocoa market, where the producers and consumers are countries or regions. The regions are arranged in such a way that the amount of beans imported by producing regions, and the amount of beans exported by consuming regions, can be neglected. (Instead of beans, bean equivalents were used, since all exports and imports of intermediary products were transformed into bean equivalents.) Suan Tan (1984) reviews the theory underlying the construction of this type of model. The sampling period is 1955-1982 and the data originate mainly from FAO publications, the International Cocoa Organization and Gill & Duffus.

The producing countries or regions are Cameroon, Ghana, Nigeria, Ivory Coast, Africa Rest, Brazil, Rest South America and Asia and Oceania. The (normal) production of cocoabeans QR is based on two factors, the area planted and the (average) production per acre. In contrast to Akiyama and Duncan (1982), who introduce two different relations, one for acreage and one for yields, only one relation for the production of cocoabeans per country or region is introduced in the present model. The reason for this is that the data for acreage are unreliable (FAO 1985). Besides, under fairly realistic assumptions it is not necessary to introduce two relations (Ady 1968; Bateman 1965). The decision on acreage and production is based on the development (or expectations) of real producer prices PFI/PC as an indicator for profit expectations. This leads to

$$\Delta(\ln(QR_t)) = \beta_0 + \sum_{p=0}^{8}\beta_{p+1}\ln\left[\frac{PFI}{PC}\right]_{t-p} + \beta_9\ln(QR_{t-1}) \quad . \qquad (1)$$

The consuming regions are North America, Western Europe, Eastern Europe (including the USSR) and Rest of the developed World. Cocoa consumption per capita CC/POP is based on real gross per capita income GNPR/POP and real cocoa prices. The real import price PI/PC is used to represent the

real cocoa price. The real price of sugar PS/PC is introduced to account for possible substitution or complementary products. As a measure for cocoa consumption grindings are used, adding the imports of powder, paste and butter transformed into bean equivalents, in order to cover the change in imports from beans to intermediary products, especially in the trade between North-America and Brazil. The specification used is:

$$\ln\left(\left[\frac{CC}{POP}\right]_t\right) = \beta_0 + \beta_1 \ln\left(\left[\frac{GNPR/PC}{POP}\right]_t\right) + \beta_2 \ln\left(\left[\frac{PI}{PC}\right]_t\right) \qquad (2)$$

$$+ \beta_3 \ln\left(\left[\frac{PS}{PC}\right]_t\right) + \beta_4 \ln\left(\left[\frac{CC}{POP}\right]_{t-1}\right) .$$

The price system contains relations for producer prices PFI in home-currency, for export prices PE and import prices PI in US-dollar cents. Due to government policy and quality differences, export and import prices and the world market price PICCO are not only related through the exchange rates RE. For all these price equations an autoregressive distributed lag model of the first order is used. Note that by restricting the parameters it can be tested what functional form is appropriate, i.e. an error correction mechanism, adaptive expectations, etc. The resulting specifications are

$$FI_t = \kappa_1 PE_t \times RE_t + \kappa_2 PE_{t-1} \times RE_{t-1} + \kappa_3 PFI_{t-1} \qquad (3)$$

$$PE_t = \kappa_1 PICCO_t + \kappa_2 PICCO_{t-1} + \kappa_3 PE_{t-1} \qquad (4)$$

$$PI_t = \kappa_1 PICCO_t + \kappa_2 PICCO_{t-1} + \kappa_3 PI_{t-1} \quad . \qquad (5)$$

The world market cocoa price PICCO depends on the difference between world supply and demand. Supply QRWT is the sum of production per country or region. Demand for grindings GRWT is the sum of demand for grindings per region. The definitional equation for total demand for grindings GRWT also

includes an autonomous component CCRR to account for imports in countries or regions which are not modelled explicitly. Differences in supply and demand will also induce changes ΔSTWT in free stocks (the factor .99 accounts for transportation losses). It is assumed that consuming regions keep a fraction of the demand for grindings in stock for production of cocoa products. This desired level of stocks is set equal to the average level of stocks over the period 1962-1982, which is 30% of total grindings GRWT. In as far as last years stocks STWT differ from the desired level this difference will have a negative effect on the price for cocoa. In a situation of changing demand this will also induce a change in the demand for consumption in order to obtain total demand GRWT+.30ΔGRWT. Since markets are not independent, the commodity price index CPI is included in the specification in order to separate the effect of differences in supply and demand on the cocoa market from the spill-over effects from other markets. Indicators for the instability of monetary variables did not have any significant influence. The relevant definitional equations are

$$QRWT_t = \sum_{i=1}^{8} QR_{ti} \qquad \text{(World Supply)} \quad (6)$$

$$GRWT_t = \sum_{j=1}^{4} GR_{tj} + CCRR_t \qquad \text{(World Demand)} \quad (7)$$

$$STWT_t = STWT_{t-1} + [.99 \times QRWT_t - GRWT_t] \qquad \text{(World Stocks)} \quad (8)$$

$$\ln(PICCO_t) = \alpha_0 + \alpha_1 \ln(CPI_t) - \alpha_2 \left[\frac{QRWT_t - (GRWT_t + .30\Delta GRWT)}{GRWT_{t-1}} \right] - \alpha_3 \left[\frac{STWT_{t-1} - .30 \times GRWT_{t-1}}{GRWT_{t-1}} \right] + \alpha_4 \ln(PICCO_{t-1}). \quad (9)$$

The model also includes a submodel for the calculation of the opportunity costs and operational result of buffer stock operations. The opportunity costs are based on the cash-flow from buying and selling cocoabeans by the buffer stock manager, minus the interest on an annual virtual loan to

finance the buffer operations, minus the costs of keeping the beans in a warehouse in the United Kingdom (storage, insurance, rotation). The interest paid is based on a real interest rate of five per cent per year. The estimated costs of keeping 1000 MT of cocoabeans in stock are based on information gathered by UNCTAD (UNCTAD 1975) and private correspondence with the ICCO. The costs are indexed on Manufacters Unit Value (MUV). The operational result is equal to the opportunity costs without the annual loan to finance the buffer, but including the interest gained from the surplus funds of the ICCO. These surplus funds are what remains of the contributions -2 US-dollar cents per lb- after the bufferstock operations. The operational result is of special interest to the members of the ICCO, since it indicates to what extent the buffer operations need extra finance apart from the arrangements already made.

Implementation of the Agreement in the Model

The agreement contains two instruments and two adjustment mechanisms for the price range (see section 2) which have to be translated in terms of the model. Since the model is based on annual data our interpretation of the instruments in the agreement will deviate from their exact content.

(i) The buffer stock can be implemented easily in equation (4). This is not the case for adjustment of the intervention prices by 13 U$ cents per kilo if the buffer stock manager has to sell or buy 75,000 mt within six months. In the model this was translated into an adjustment of intervention prices each time the buffer stock manager has sold (bought) 75,000 tons within one year. After one adjustment within one period, the simulation was restarted using the adjusted intervention prices. The program allows for two of these adjustments within one period.

(ii) Withholding has the same effect on prices as a buffer stock mutation. In the model, withholding starts when the maximum buffer of 250,000 mt has been reached, up to a maximum of 120,000 mt, without employing tranches. Withholdings are sold whenever the actual cocoa price exceeds the reference price. The amount sold will keep the actual price equal to the reference price.

(iii) Implementation of the annual price review is straightforward.

(iv) The intervention prices are adjusted each calender year instead of each cocoa year.

Implications of the Model

Instead of all the detailed information on the estimation results, only the effects of the world cocoa price PICCO on production and consumption, and the effect of a change in real gross national income per capita are reported. These effects are given in table 1 and table 2. Compared to other

Table 1: Price elacticities of Cocoa Production

	Short Run	Long Run
Cameroon	.13	.73
Ghana	.10	.38
Ivory Coast	.42	.82
Nigeria	.20	.47
Brazil	.25	.29
Rest Latin America	.14	.28
Asia and Oceania	.0	.50
World Total	.23	.54

Remark: Short Run means current and 1 year lag.
Long Run means steady state elasticity.
For Africa Rest we used a dummy equation which describes the development of production over time.

Table 2: Price and Income Elasticities of cocoa consumption

	price		income	
	short run	long run	short run	long run
North America	-.19	-.25	.21	.25
Western Europe	-.11	-.15	.25	.30
Eastern Europe + USSR	-.14	-.26	.44	.66
Rest World	-.26	-.40	.42	.57
World Total	-.16	-.23	.30	.39

studies of the cocoa market by the World Bank (Akiyama and Duncan 1982) and the International Cocoa Organization ICCO (1984) the results for North America and Western Europe are of the same magnitude. For Eastern Europe and the USSR the price elasticities obtained differ. This is partially due to differences in the definition of the region. With respect to the rest of the developed world the results are close to those of the ICCO, but differ from the results of the World Bank. There are, however, no real anomalies between the various results, only differences in magnitude.

The short run price elasticities of production and consumption are quite low. The short run elasticity of production for the world is fifty per cent higher than the corresponding elasticity of consumption. The difference in magnitude increases over time. This is due to the fact that in the short run producers can only react on prices by taking better care of the existing stock of trees. In the long run the stock of trees can be adjusted.

The income elasticities, both in the short and the long run, are low in North America and Europe, which points at saturation of the market. In Eastern Europe and the USSR, and the rest of the developed world income elasticities are considerably higher.

Simulation Exercises

In order to test the strength and weakness of the 1986 cocoa agreement, a number of simulation experiments were performed, based on the following assumptions: a zero growth and an annual two and three percent growth over a period of 25 years of the commodity price index CPI (for the sake of simplicity identified with the period 1986-2010). Fluctuations around the trend are constructed by calculating the trend over the past and taking the dif- ference between this trend and the actual data. The fluctuations obtained thus are added to the trend used for the different experiments. These different assumptions are necessary in order to see if the agreement is robust enough to adapt to an inflationary environment. Fluctuations are introduced by taking the historical differences of the actual values of the commodity price index CPI and its geometrical mean. Since the exchange rates are exogenous it is assumed that they are constant over the simulation period. The consumption prices are linked to the development in the commodity price index. In this way unneccessary complications as a consequence of differences in development of exogenous variables are avoided. The free simulation of the model performed reasonably well (measured in Theil's inequality coefficient) over the period 1968-1980.

4 A HEURISTIC RULE FOR INTERVENTION

In the literature two types of stabilization policies are distinguished. The first one is a band width rule or price range. The price range has as a disadvantage that it restricts the price variation to a pre-specified range and does not take into account circumstances from outside the market which might force the price out of the range. The second one is a price adjustment rule which means that the buffer stock manager keeps the price as close as possible to a pre-specified target price path. This kind of rule results from an optimal control formulation of the problem. The disadvantages of an optimal control formulation of the problem are that it restricts the functional form of the model to linear models, and that it

is necessary to model an objective function explicitly. Another disadvantage is that all future target prices for the planning horizon have to be known in advance in order to be able to apply the rule (Lee and Blandford 1980; Ghosh et al. 1982). The 1986 cocoa agreement is a mixture of both policies: there is a price range of 80 US-dollar cents and there are two instruments to keep the price within the range, and there are also two instruments to adjust the reference or target price (see section 2). The question is: do these instruments enable the buffer stock manager to reduce the variance of the cocoa price and/or is it possible to formulate a better rule for application of one or more of the instruments?

The policy implicit in the agreement can be formulated as a simple closed loop buffer stock rule of the form

$$\begin{cases} \Delta(BST_t) = f_1(PICCO_t, PICCO_t^*) \\ PICCO_t^* = g_1(PICCO_{t-1}, \Delta(BST_{t-1}), CPI_t^e) \end{cases} \tag{10}$$

where $PICCO_t^*$ is the target price, ΔBST_t the change in bufferstock and CPI_t^e the expected commodity price index. This approach seems more realistic than applying optimal control given the practical situation the buffer stock manager has to deal with. A disadvantage is that it is not possible to prove that the agreement leads to optimal results. It can only be shown that over a longer period of time it is satisficing.

In order to be able to do this the two principles of section 1 have to be translated into variables of the model. Translation of the principle that a decision rule should adjust for fluctuations in supply and demand in such a way that it does not effect the price trend induced by supply and demand, but only reduce the variance of the price, means that two conditions should be met (see (9)):

$$QRWT_t - (GRWT_t + .30\Delta(GRWT_t)) = \Delta(BST1_t) \tag{11}$$

$$STWT_{t-1} - .30 \times GRWT_{t-1} = \Delta(BST2_t) \ . \tag{12}$$

(11) implies short term market equilibrium, whereas (11) and (12) together imply long term equilibrium because stocks are at their desired level. The total buffer stock mutation necessary to achieve the desired target of long term market equilibrium is

$$\Delta BST_t = \Delta BST1_t + \Delta BST2_t \; . \tag{13}$$

This condition is the target for the buffer stock manager. Implementation in (9) leads to a pragmatic target price which is calculated every period

$$PICCO^*_t = \exp\{\alpha_0 + \alpha_1 \ln(CPI^e_t) + \alpha_4 \ln(PICCO_{t-1}\}. \tag{14}$$

Since the adjustment ΔBST_t is based on production, consumption and stocks of cocoabeans only, this rule for evaluating the target price from year to year is called the rule of 'internal growth'.

The remainder of this article will examine the effect of the agreement on the variability of the international cocoa price and on the variability of income. As a yardstick for variability the following instability index is used (for a general discussion on instability indices, see Offutt 1986):

$$II = \sqrt{\left[\frac{1}{n}\sum_{i=1}^{n}(x_t - x_0(1+\dot{x})^t)^2\right]} / \; x_{mean}. \tag{15}$$

With $\dot{x} = 0$ and an appropriate x_0 this is equal to the coefficient of variation. In what follows the policy results are compared with the results of a free simulation.

5 SIMULATION RESULTS

The Agreement

In the case of a zero growth trend in prices, the agreement does not affect the world production and consumption of cocoabeans (on average -1,800 mt and +1,600 mt respectively on an average annual world production of approximately 1.9 milion mt). There is no change in the market shares of the different countries and regions either, which implies that the agreement is neutral with respect to production and consumption. On average, income and spendings are -.25% lower compared to the free simulation, due to a small decline of the cocoa price (-1.4 US-dollar cent per kilo). This implies that the agreement is also neutral with respect to the nominal variables. So the agreement is in line with the new Unctad guidelines (section 2).

Table 3: The Effect of the Agreement on the Variability of Prices and Income

	instability index simulation	agreement	decrease in percentage
Prices:			
PICCO	36.9%	26.8%	27.3%
PICCO/CPIG	29.1%	24.3%	16.7%
Income:			
Brazil	20.4%	16.5%	18.9%
Rest Latin America	24.5%	21.2%	13.4%
Cameroon	27.2%	23.3%	14.3%
Ghana	47.7%	41.6%	12.9%
Ivory Coast	21.5%	17.6%	17.9%
Nigeria	53.0%	47.6%	10.1%
Rest Africa	30.9%	27.4%	11.4%
Asia & Oceania	9.4%	8.1%	13.7%
Total	20.1%	17.5%	12.9%

Because of the intervention the instability index of cocoa prices is reduced from 36.9 (free simulation) to 26.8 (see table 3), a reduction of more than 25 per cent. As a corollary the amplitude of the price range is reduced considerably: the highest price over the 25-year period decreases from 282 to 263 US-dollar cents per kilo, and the lowest price increases from 161 to 171 US-dollar cents per kilo. The lowest price instability index attainable within the agreement price range of ± 40 US-dollar cents is 19.3, based on an unlimited buffer and no price adjustment mechanism. So, the degree of stabilization reached (26.8) is quite satisfactory.

The stabilization of income of the exporting countries (equal to the expenditures of importing regions) is less significant. The index decreases from 20.1 to 17.5, the two largest producers gaining the most in terms of stabilization of income. Note, however, that all individual producing countries gain from the agreement in terms of stabilization of income.

This result is achieved with a limited number of interventions. The buffer stock manager, starting with a stock of 100,000 mt, buys stocks only once, 150,000 mt in 1990, which implies an adjustment of the price range by two times 13 US-dollar cents. The price range which was 187-267 US-dollar cents at the beginning, becomes 161-241 US-dollar cents, and the buffer is at its maximum level. The buffer stock manager uses the instrument of withholding only in 1997 (64,400 mt) in order to keep the price range constant. In the following two years 39,600 mt and 25,000 mt are sold, since in these years the price of cocoabeans becomes larger than the reference price of 201 US-dollar cents. The price range remains constant until the year 2008. To keep it constant the buffer stock manager sells 93,400 mt in the period from 2002 till 2005 without triggering an adjustment mechanism. In the year 2008 75,000 mt are sold and the price range becomes 174-254 US-dollar cents. In 2009 the remainder of the buffer is sold, which implies a new price range resulting from the fact that more than 75,000 mt are sold. However, in that year the price range is also adjusted as a result of the fact that the price of cocoabeans lies outside the range at the end of the year; consequently the price range becomes 200-280 US-dollar cents in the year 2010.

It turns out that the agreement is easily self-supporting. The operational result is on average 90 million US-dollars a year. The opportunity costs of the buffer stock operations are on average 22.7 million US-dollars a year, which is a rather low price for the stabilization achieved. It is only .5% of the avarage value of production. These figures are based on the assumption that the existing 1985 stock of 100,000 mt was bought at 1985 prices.

Variations on the Agreement Policy

Several factors indicate that the agreement can be improved upon. First, the buffer stock is not very active (6 out of 25 periods). Second, the withholding instrument is hardly used. Third, the mechanism of adjustment of the price range at the end of the calendar year is used only once. All this means that the flexibility (13 US-dollar cents) triggered by changes of 75,000 mt in the size of the buffer stock, and activated four times under the agreement policy, is too high, given the price range of $\pm$ 40 US-dollar cents. There are two ways in which this flexibility can be reduced, by smaller adjustments of the reference price, and by reducing the price range.

First, the flexibility was reduced by 50% (from 13 US-dollar cents to 6.5 US dollar cents). This results in a better performance; see table 4, agreement less flexible. This better result is attained at limited additional opportunity costs (US-dollar 9 million per year). The instability index for cocoa prices drops to 21.7 and the index for income to 14.4. This result comes close to the maximum attainable stabilization with an unlimited buffer stock; table 4, agreement max buffer stock. As under the agreement, this alternative policy stabilizes the income of every individual country/region and has hardly any influence on total income, production, consumption and average cocoa prices. Also in this case the buffer seems self-liquidating.

Table 4: Major results

result \ Policy	instability index prices	instability index income	operational result (10^6 U$)	opportunity costs (10^6 U$)
free simulation	36.9%	20.1%	-	-
agreement	26.8%	17.5%	92.1	22.7
agreement, less flexible	21.7%	14.4%	54.5	31.5
agreement, max buffer	19.3%	12.6%	60.4	117.1
agreement, ± 30 U$-cents	24.5%	18.4%	92.4	22.3
agreement, ± 20 U$-cents	20.9%	16.4%	101.8	12.9
agreement, ± 10 U$-cents	20.1%	15.4%	89.5	25.3

The very positive outcome of this variation on the agreement is not due to the fact that the buffer is more active. Rather, this case demonstrates the possible effect of activities of the withholding scheme. This scheme is active in twelve out of the twenty five years. However, it functions only in the lower half of the price range. Therefore, during this period, the prices are in fact kept within a range of 40 US-dollarcents under the reference price.

Further sensitivity analysis of the 75,000 mt price adjustment showed that the result could not be improved upon. There is also a good balance between flexibility and size of tne instruments. Increasing the maximum buffer stock and/or the maximum withholdings does not lead to better results.

The alternative for a reduction of flexibility is a narrowing of the price range. The most significant result was reached after reducing the range to ± 20 US dollar cents. The result of this reduction is almost equal to the result of the variation on the agreement with reduced flexibility; see table 4. The only, but important, difference is that the costs of stabilization are much lower, amounting to less than 13 million US-dollars per year. Further reduction of the price range leads to a slightly better result but at the expense of doubling the real costs of the agreement.

The results of a policy with a ±20 US-dollar cents price range can not be improved upon by changes in the mix of instruments. The result does not depend on an active withholding mechanism. The buffer is very active and - at least as important- the price adjustment mechanism becomes operational quite frequently. As with the other variations discussed, the policy is neutral with respect to the long run market trend.
Till now the operation of the agreement has been analysed in an inflation free world. Next, the effect of inflation on the functioning of the agreement is analysed.

The Agreement in an Inflationary World

In an inflationary world the agreement becomes ineffective after a number of years. The higher the rate of inflation, the shorter this period will be. In case of an annual increase in the trend of the commodity price index CPI of 1% per year, the buffer manager buys 130,000 mt in 1990, which keeps the price within the range for a total period of twelve years. Then inflation catches up with the price range. The price range is gradually increased in the following years, and the buffer is empty within two years (after the twelfth year). The buffer remains empty and becomes ineffective. Because of the operations of the buffer stock, the price stability index declines from 37.9 to 28.7, but incomes are only marginally stabilized; see table 5. This implies that the agreement is not neutral with respect to price changes from outside the market.

Table 5: Major results under alternative assumptions on inflation

result \ Policy	instability index prices	instability index income	operational result (10^6 U$)	opportunity costs (10^6 U$)
0% inflation				
free simulation	36.9%	20.1%	-	-
agreement	26.8%	17.5%	92.1	22.7
agreement, ± 20 U$-cents	20.9%	16.4%	101.8	12.9
internal growth ±5%	16.6%	15.4%	102.6	11.9
1% inflation				
free simulation	37.9%	19.8%	-	-
agreement	28.7%	18.9%	138.8	14.7
agreement, ± 20 U$-cents	24.2%	18.7%	160.5	- 7.1
internal growth ±5%	16.0%	15.4%	136.6	16.1
3% inflation				
free simulation	38.1%	19.1%	-	-
agreement	29.4%	18.2%	294.7	-39.4
agreement, ± 20 U$-cents	23.0%	18.2%	291.9	-36.5
internal growth ±5%	18.6%	16.9%	211.5	40.2

In case the rate of inflation doubles or triples, the period after which the agreement becomes ineffective in ten and seven years respectively. The stabilizing effect is therefore less than in the case of one percent inflation.

These results indicate that even a moderate rate of inflation paralyzes the functioning of the agreement. Consequently, given the structure of the agreement, it will be necessary to renegotiate the price range regularly. With one percent inflation renegotiation is necessary every five years, and in case of three percent inflation at least every three years. The question is: can these regenotiations be avoided?

Application of the rule of Internal Growth

If the buffer stock manager would base his policy on (13) and (14), long term market equilibrium can be achieved. In order to apply this rule, it is assumed that the expected commodity price index CPI_t^e is equal to the actual commodity price index CPI_t. This rule of 'internal growth' is superior to the agreement in all cases; see table 5. A range of plus/minus five percent is used for practical reasons, not every minor difference in demand and supply has to be taken into account, only larger ones are of interest. (Turnovsky (1978), and Newberry and Stiglitz (1982) emphasize that in a theoretical setting, perfect price stability is either not feasible or infinitely costly.) Note that incomes too are stabilized to a greater extent. Moreover, in the case of zero growth the opportunity costs of this policy are also lower if compared with the agreement.

In an inflationary world the results under a rule of internal growth plus/minus five percent do not deteriorate. Stabilization is reached, although at a certain price. This is in sharp contrast with the agreement, which becomes ineffective. As in the case of the agreement in a non-inflationary world, the rule of internal growth is also neutral with respect to the long term trend of the world cocoa market. Neither production nor consumption or stocks are significantly influenced by such a stabilization policy.

6 CONCLUSIONS

The semi-automatic price adjustment mechanism and the two intervention instruments of the 1986 cocoa agreement augur well for its success. It is quite likely that the agreement has a substantial stabilizing effect on prices and incomes. The operational result of the buffer stock under various circumstances, indicates that no additional funding is required to finance the buffer stock operations. The opportunity costs are also relatively low. The analysis indicates, moreover, that the effectiveness of the agreement can considerably be enhanced by halving the width of the price range. An essentiial pre-condition for success of the agreement is, however, that its potential flexibility is fully utilized. The dispute over price adjustment and withholdings that arose in the spring of 1988 between producers and consumers, is therefore most unfortunate.

However, even only moderate inflation of world commodity prices will make the agreement ineffective after a few years. Consequently periodical and most likely cumbersome renegotiations of the price range will be necessary.

The functioning of the agreement can be improved by the application of a rule which is neutral with respect to disturbances from outside the market, but which neutralises the internal disturbances. Price stabilization would be reached to a higher degree and periodical renegotiation of the price range would no longer be necessary.

Application of the rule of internal growth is only possible when the price development of commodity price index CPI for the current period is known. This means that the buffer manager needs a good indicator for the development of this price index based on information from the best equipped organizations. It seems, however, that the ICCO, possibly in co-operation with organizations like the IMF, the World Bank and/or the FAO, should be able to make projections which are reliable enough to apply a buffer policy based on the 'internal growth' rule. With this requirement fulfilled,

practical application of such an heuristic rule is still not without problems. The actual short run apllication requires additional research and modelling.

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